Health and Fitness

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Condition physique et Sport amateur

Canada

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Table of Contents

Foreword

It is a great pleasure to publish in Canada this booklet *Health and Fitness* by the eminent Swedish exercise physiologist Dr. Per-Olof Astrand. Dr. Astrand originally wrote this booklet in Swedish for his own countrymen but what he had to say to Swedes applies equally to Canadians, since the lack of fitness is an international problem.

The benefits of exercise are hard to comprehend without firsthand experience. All the testimonials about how exercise can help a person feel and look better, cope with stress better, reduce mental and physical fatigue, and enjoy the social aspects of physical activity are meaningless until you participate and discover them for yourself. It is our sincere hope that some of this information will prompt you to include regular physical activity as a necessary but enjoyable part of your life.

Summary

During the past century, people in industrialized countries have radically reshaped the environment in which they live. Technical devices of all kinds have assumed an increasing amount of the work formerly performed by muscle power. In most cases changes were for the better. But they have also created major problems.

One of these problems is that the individual, originally designed for hard physical labor in the Stone Age, must adapt to a world dominated by technical innovations. Modern man must appreciate that regular physical activity is necessary if he is to function properly. Part of the ample spare time which we all enjoy — as compared to previous generations — must be utilized for **active** recreation.

Many dangers threaten if we do not follow this advice: a reduction in the capacity of certain vital body functions, obesity, malnutrition, an increased risk of contracting certain diseases, reduced resistance and general fatigue. However, man is by nature a rather lazy creature, a gambler who takes high risks in the hope that he is the exception to the rule, that everything will work itself out for him in the end.

That is why emphasizing the dangers of smoking, alcohol, narcotics, and general physical inactivity is seldom effective. People devote more attention to maintaining the good condition of their cars and their pets than to their own health. But it is of vital importance that we should be physically fit in order to manage our daily work and make our leisure time meaningful. Two or three half-hour periods of rational training every week are sufficient to build up and maintain good physical fitness.

People often ask, "Should I have a medical check-up before I start training?" The answer must be that everyone who is in doubt about the condition of his health should consult his physician. But as a general rule, moderate activity is less harmful to the health than inactivity. You could also put it this way: a medical examination is more urgent for those who plan to remain inactive than for those who intend to get into good physical shape!

The Canadian Scene

Canadians are unfit. A recent Saskatoon study to determine the fitness of the average Canadian showed that we were not only below Scandinavian norms but even below norms set by the American Heart Association. Forty percent of men and 47% of women had fitness levels which could be classified as fair or low. Unbelievable as it may seem, women are less fit than men, with teenage and 20-29 year old women rated the lowest.

Not only adults suffer the effects of indolence; most Canadian children are also unfit. To quote a noted Canadian researcher in physical education:

> "For the ordinary Canadian child physical fitness . . . seems to be a decreasing function of age from the time we put him behind a desk in our schools."

In a ten-year longitudinal study of school children it was found that cardiovascular fitness declines steadily from the age of eight, stabilizing, at a very low level, only in late adolescence.

In the face of this evidence it is not surprising that Canadians are also fat. The recently completed Nutrition Canada Study revealed that over one-half of the adult Canadian population was overweight. However, what **is** surprising is the finding that those who are fat eat the same number of calories as those of normal weight. Since our weight is a balance between the energy, in calories, that we eat and the energy that we expend in exercise, the problem of obesity must lie with our sedentary lifestyle.

It is not difficult to understand why we are unfit and overweight. Food, though often expensive, is plentiful and usually a pleasure to eat. If we eat 100 calories more than we need each day, we would gain 10

pounds by the end of the year. This could be prevented simply by a daily, brisk, one-mile walk with the dog.

Unfortunately in our society, we need only minimal amounts of physical activity to get us through the average working day. Even if we want to exercise, the temptations of inactivity are too great. Our automobiles tempt us away from walking, elevators from stairs and, most importantly, the television tempts us away from any other activity that might use up a little energy.

A study of leisure-time activities in Canada showed that 40% of Canadians watch more than 15 hours of television every week and 13% watch more than 30 hours a week. The same study showed that only 20% of the population engage in some form of physical activity such as walking for pleasure, jogging, hiking or other exercise — 80% were completely inactive. It must be mentioned that the survey was carried out in the winter months from January to March, which would bias the findings somewhat. However, remember that most of Canada is covered with snow five months of the year. If we are to become a fitter nation, we must accept our lot and become more active in both winter and summer.

The influence of our lifestyle upon health in Canada has been highlighted in the Working Paper on Health published by the Department of National Health and Welfare. The way in which we eat, exercise, smoke, drink and drive, in short the way in which we live, has a significant influence upon our risk of contracting many diseases. In a sense, many of the major health problems in Canada such as coronary heart disease, automobile injuries, cancer of the lung, etc., can be considered diseases of choice. The responsibility for the prevention of these lifestyle health problems lies with ourselves. Unless we change,

there is little hope that, despite the efforts of our health care system, we as a nation will improve our collective health.

Departments of Health across Canada are concerned about the fitness of Canadians. Recreation Canada of the Department of National Health and Welfare called a National Conference on Fitness and Health to call attention to the epidemic of unfitness in Canada. The conference focussed on the relationship between fitness and health, and brought together physicians and physical educators to discuss the problem and suggest ways and means of motivating Canadians to become more physically active.

Dr. Astrand has spent a lifetime in the study of how we humans exercise. Besides being a scientist of world-wide repute, he is an excellent writer who can explain, clearly and with vitality, how our bodies respond to exercise.

It is not surprising that a Swede should tell us how we should exercise. Many of us remember with chagrin the message from Participaction that a "60-year-old Swede is as fit as a 30-year-old Canadian". Perhaps this is stretching the truth a little, as Participaction has the right to do in marketing fitness in Canada. However, stretched as it may be, it does have impact and it does have more than a grain of truth.

This booklet is one step in the direction of motivating Canadians to become concerned about their lifestyles and to stimulate them to do something about it! We hope that, after reading this booklet, you will understand how exercise can improve your fitness, and that maintenance of an adequate fitness level is essential for positive health throughout life.

References

1. A Current View of Cardiorespiratory Fitness Levels of Canadians. *Bailey, Shephard, Mirwald and McBride, Saskatoon, 1973.*

2. Exercise, Fitness and Physical Education for the Growing Child — A Concern. *D. A. Bailey. Presented to the National Conference on the Child in Sport and Physical Activity. Kingston, 1973.*

3. Nutrition: A National Priority. *A report by Nutrition Canada. Health and Welfare Canada, 1973.*

4. A Leisure Study — Canada 1972. *Kirsh, Dixon and Bond. Secretary of State for Canada, 1973.*

Health and Fitness

Introduction

"Prevention of disease has attracted much less attention than its diagnosis and treatment. It obviously deserves the first priority, but it is less dramatic than surgical procedures, is rarely asked for by the not-yet-educated public, and the doctors are overworked simply taking care of sick people." Paul Dudley White (In "My Life and Medicine", Gambit Inc., Boston 1971).

In many countries cardiovascular diseases often account for more than 50% of all deaths. Naturally this fact motivates the intensive research presently being carried out to discover the genesis and treatment of such diseases. They certainly cause personal suffering and their social and economic consequences are enormous. In many countries medical care is actually one of the largest industries, with a direct budget that has increased enormously during the past decades. In Canada, it has increased from 2 billion dollars in 1960 to more than 7 billion dollars now — a rise of some 14% per year. In Sweden, with a population of 8 million, the health budget covered by direct tax revenue is now close to 2 billion dollars.

However, more money does not inevitably equal better health. Longevity, measured as the average remaining lifetime, increased markedly in Canada in each decade from 1900 to 1960 but appears to have reached a plateau in the early sixties. Since that time there has been virtually no increase for males and only a slight increase for females.

Admittedly, life expectancy is in no way an accurate reflection of the state of health of a country. Life expectancy is determined from the death rate, whereas we measure our health not when we die but while

we live. The health of a country can only truly be measured by the quality the life led by its citizens. Actually, the increase in life expectancy over the past 70 years is largely due to a reduction in deaths in infants. In fact, the life expectancy of a 40-year-old man over the past half decade has increased by merely one year! Many diseases, particularly infectious diseases, have effectively been conquered, but diseases of a degenerative nature, particularly cardiovascular disease, have increased extensively. One cannot avoid the thought that our modern way of life could be one important factor and that the main determinants of longevity are now more cultural than medical. Here let it merely be pointed out that several factors such as heredity, diet, and way of life seem to be important in the development of cardiovascular diseases. Individuals showing high blood pressure, obesity, a high concentration of cholesterol in the blood, or a combination of these, run a higher risk of death from cardiovascular diseases than the non-obese with normal blood pressure and a low cholesterol level. In recent years interest has been focussed on the possible role of physical inactivity in the genesis of these diseases. The pioneer in studies of the "epidemiology" of cardiovascular diseases, Morris, has emphasized that "habitual physical activity is a general factor of cardiovascular health in middle age, and that coronary heart disease is in some respects a deprivation syndrome, a deficiency disease".

The first traces of arteriosclerotic changes in the blood vessels can be found in many teen-agers. But if those changes have not reached an advanced stage they are reversible. When well established, the condition is much more serious. In any case, it may be time for preventive action now. This may concern your own "body and soul" as well as the future health and well-being of your children.

It is unrealistic to permit the cost of medical care to increase at the same rate as during recent decades. It would soon consume the total gross national income. Instead, much more effort and time should be devoted to preventive health programs. This booklet presents a summary of the physiological and medical information which analyzes, the connection between health and fitness. This type of message has proved to be quite successful — at least in Sweden!

The human body — a working machine

In most animals, the demand for good mobility dominates body construction. This also applies to man. Forty percent of our body weight is normally made up of muscles and 15% of the skeleton. Many of our important organs and functions are dimensioned and designed to give service to the muscles during work, organs such as the heart and respiratory system. With the body at rest, the heart pumps out about 5 liters* of blood every minute at the same time as 5 - 8 liters of air are inhaled by the lungs. However, the heart's construction permits it to pump 15 - 20 liters or more of blood per minute and pulmonary ventilation may exceed 100 liters per minute. The nervous system can also be said to be dominated by the body's demand for motion. To a large extent, the nerves receive and provide impulses which result in muscular movements: speech, gestures, physical work, running, etc., depending on the situation. The brain could undoubtedly be constructed more simply if there were no need to coordinate muscular movements.

The human body is built for action, not for rest. This was a historic necessity: the struggle for survival demanded good physical condition. But optimal func-

tion can only be achieved by regularly exposing the heart, circulation, muscles, skeleton and nervous system to some loading, that is to say, training. In the old days the body got its exercise both in work and at leisure. However, in our modern society machines have taken over an ever increasing share of the work elements which were formerly accomplished with muscular power alone. Our environment has come to be dominated by sitting, riding and lying. Thus, the natural and vital stimulation that tissues and internal organs receive through physical work has largely disappeared.

Physical performance

In competitive sports an individual is evaluated according to his performance. An objective measurement of time or distance is often made, but in many sports evaluation contains a subjective element, for example in gymnastics, figure skating and high diving. Technique is vital in some sports; endurance or speed is decisive in others. The ability to perform is dictated by how well the individual satisfies the demands imposed by the sport.

The following list, which will be discussed later, may be useful in making a more detailed analysis:

Performance demands:

1. Energy output ("motor power")
   — aerobic processes ("combustion engine", with oxygen)
   — anaerobic processes (without oxygen)

2. Neuromuscular function
   — technique
   — strength

*1 liter = 1.1 Imp. qt

3. Psychological factors
   — motivation
   — tactics

Energy yield

Every cell in the body is essentially **a combustion engine.** The fuel is glycogen (a kind of carbohydrate) and fatty acids. The cell, like an engine or a fire, also needs oxygen. The "waste products" are carbon dioxide and water.

Breathing conducts air containing 21% oxygen down to the alveoli in the lungs. The hemoglobin in the red corpuscles of the blood then takes charge of the transportation of oxygen to the cells. Here the oxygen is exchanged for carbon dioxide which is carried back to the lungs and disappears with exhaled air. For every liter of oxygen consumed by the body, a certain amount of energy, approximately five kilocalories (kcal) or 20 kilojoules,* is liberated. Oxygen uptake can be measured when the body is at rest and at work. In this manner, a measure of the energy yielded aerobically by the body is obtained.

If a subject performs a maximum effort for five minutes on a bicycle ergometer or treadmill and oxygen uptake is measured, a measure of the maximum power of the combustion engine is derived. Since oxygen is transported by the blood, the figure for oxygen uptake also gives an evaluation of the load on the heart and circulatory system. The greater the maximal oxygen uptake (technically called the maximum aerobic power), the greater the heart's ability to pump.

In the initial phase of a job or during very heavy work, the muscles can make use of an **anaerobic ("without oxygen") engine.** Energy yield takes place in the absence of oxygen by the splitting up of energy-rich substances (including glycogen) into less

* Kcal = 4.2 Kilojoules (kJ)

energy-rich substances, thereby releasing energy for muscle work. However, the ability to work generated in this manner is very limited. Various products (including lactic acid) act to "poison" the muscles so to speak. Anyone who ever ran the 400 meter dash and started his spurt too early wil know what I mean: the muscles stiffen and refuse to obey orders. So this anaerobic motor dominates in intensive muscular work for a minute or two, but the longer the duration of the work, the more important it is for the duration of the work, the more important it is for the combustion engine to attain a high power output.

Neuromuscular function

All bodily movement is based on a complicated interplay between different groups of muscles. The central nervous system works somewhat like a computer. Nerve cells in the spinal cord extend their fibers to the muscle cells in the trunk and extremities. Impulses may be generated in these nerve cells which, via their nerve fibres, activate muscle cells. Well-coordinated activation or inhibition of the nerve cells of different muscle groups makes it possible to execute efficient and skillful movements. When the flexor muscles of the arms are at work, for example, the arm's extensor muscles are automatically "disconnected".

To a great extent the muscles are controlled by sensory organs in the muscles, the muscle spindles, which report to the central nervous system on the muscles' degree of tension. If the initial muscular force used was insufficient, the muscle spindles can indirectly correct this by reflex action.

Many movements are inborn movements but the majority are the result of learning. This means that a certain "wiring pattern" is formed by the activation and inhibition of nerve cells in the spinal cord according to a very exact chronological pattern. Move-

ments are guided via different sensory organs and, in principle, there is a conscious intervention only when motion is to be initiated or terminated.

In view of this, it should be obvious that technique and muscular strength are not only determined by the characteristics of the muscles but to a large extent by the function of the central nervous system as well. When a certain movement has been practiced, thereby increasing muscular strength, the muscles involved increase in mass somewhat at the same time as the discharge of nerve impulses becomes more efficient. The result is that strength improvement is primarily bound to the particular movement(s) practiced. In some other activity in which the same muscle group works with another "wiring pattern," the effect of the specific training is, accordingly, rather modest.

Psychological factors

Sometimes we may be in the mood for physical exercise and sometimes not. In certain situations we feel that we could move mountains but at other times nothing seems to work.

Certain areas of the brain hold a key position in the question of coordinating muscles, for example with respect to the sensitivity of muscle spindles. Activity in this context is influenced by, among other things, a person's mood. As a rule, muscle cells cannot be brought to maximum contraction with the aid of the will power alone. But in certain situations, such as through the influence of hypnosis, the promise of reward, in conjunction with strong encouragement or in situations of danger, strength may increase beyond normal limits (some sort of emergency reaction).

Thus, the ability to perform may vary from day to day without any change in the training status or without

the influence of illness. Moreover, not everyone is equally interested in heavy physical labor. Some people actually like to torture themselves while others are lazy and give up as soon as they start to feel physical resistance.

Work tactics are also of great importance. A person with severely impaired respiratory, cardiac or circulatory function can manage rather heavy work if he or she takes frequent micro-pauses, that is to say, 10 - 30-second rest pauses interspersed with equally long periods of work.

Age and sex

For work with large muscle groups, the combustion engine, i.e. the aerobic energy yield, plays an important part. The greater the oxygen transport ability, the greater the maximum energy output of this combusion engine. Fig. 1 shows how maximum oxygen uptake (and indirectly the cardiac function) changes with age in moderately well-trained persons from 4 to 65 years. Before the age of 12, the values for boys and girls are very similar. But after puberty the maximum aerobic power of boys is greater than that of girls. The highest value is achieved in the twenties and the curve then falls so that a 60-year-old has about 70% of the value of a 25-year-old.

Women's mean values are 25 to 30% lower than men's. However, the difference among individuals is greater. A 65-year-old man may have higher values than a 25-year-old. Top-class women athletes produce maximum motor power greater than most men's. A 25-year-old woman has on the average values greater than a 65-year-old man. Professions considered physically unsuitable for women may be equally unsuitable for older men. Top athletes can attain a maximum of 6.0 liters/min or even higher.

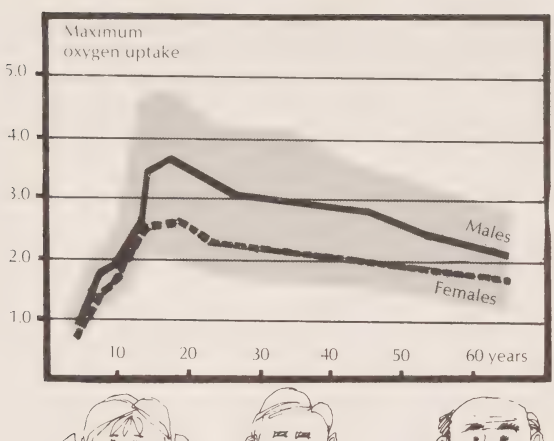


Fig. 1. Maximum oxygen uptake changes in this way for healthy, moderately well-trained persons from 4–65 years.

Training can increase maximum oxygen uptake by 10-20% or more. However, natural endowments play such a great role in providing a human engine with high power that a completely untrained person may have a maximum oxygen uptake which is greater than the mean value in Fig. 1. A well-trained person may have a lower maximum oxygen uptake than the average and, accordingly, a relatively low level of performance.

Studies have proved that we, with regular training, can counteract (if not completely prevent!) the decline in maximum motor power which usually accompanies increasing age beyond 20. We could put it this way: if two 50-year-olds are identical in endowment but one is trained and the other untrained,

then the trained person would have an oxygen uptake ability (and maximum motor power) on the same level as the untrained person had around the age of 35 - 40. **In other words, moderate training can lead to a 10 - 15 year biological rejuvenation in this respect.**

There may be many reasons for the decline in maximum oxygen uptake with advancing age. Gas exchange in the lungs becomes less efficient, maximum breathing capacity decreases and the gas exchange between the lungs and the blood becomes less efficient. Since the elasticity of blood vessels declines, demands on the heart's pumping ability increase at the same time as blood supply to the heart's own muscle drops off. Maximum heart rate drops from about 200/min in the youth to about 160/min around the age of 70. The muscle mass and maximum muscle power also decline.

Part of this decline is the inevitable result of aging, but is probably also a consequence of our changed way of life. Sports and relatively strenuous outdoor life have been replaced by more sedentary activities. The body does not take long to adapt itself to reduced demands which impair work ability. It may also be a question of a chronic malnutrition (see below), but regular exercise and improved diet can counteract this decline.

Adaptation to inactivity — and activity

The saying goes: "You can get used to anything." This is indeed a fortunate attribute. You can get used to heat, cold, high altitudes, heavy work — and to inactivity as well. The latter represents the reverse side of the coin. We are scarcely aware of what happens to our bodies when we are too inactive. But

various methods of study can disclose major and sometimes dramatic changes.

The extreme form of inactivity is continuous confinement to bed. Volunteers who submitted to bed recumbency for weeks reacted with skeletal decalcification, reduced blood volume, reduced muscular mass and impaired ability to take up and transport oxygen due to reduced stroke volume and cardiac output. A marked increase in heart rate, at rest and particularly when working, is one easily detected change.

A job which is normally accommodated by a heart rate of 120 beats/min may require 170 beats/min after several weeks of continuous bed rest. Reduced heart muscle strength and less efficient regulation of blood circulation (you feel dizzy and may even faint when standing up) contribute to this elevation in heart rate. In order to pump a certain quantity of blood, the heart must compensate for impaired stroke volume by beating more rapidly. This is unfavourable, since the heart muscle requires more energy and blood supply the greater the heart rate at a given cardiac output. This rapid decline in physical condition creates very awkward medical problems, particularly with a view to quick rehabilitation of a patient. Anyone who has had an arm or leg in a plaster cast for some time has surely observed how rapidly muscular mass, power and mobility are reduced. In many cases, rational physical exercise during convalescence can rapidly restore the patient's ability to work. Geriatric care would also be facilitated if older people could be activated and trained in some way. This is a severely neglected social and economic issue.

Until recently, one group of patients was doomed to inactivity and poor physical condition; namely, cardiac patients who had suffered from a heart attack

(with occlusion of coronary vessels). Now, there are very positive reports from many parts of the world about the beneficial effects of physical training of such patients: their maximal oxygen uptake increases; the heart rate slows down; they feel better; they become less anxious; their self-confidence improves.

Any muscular activity requiring increased oxygen uptake will also lead to training of the heart and circulation, that is to say, improved physical condition. The

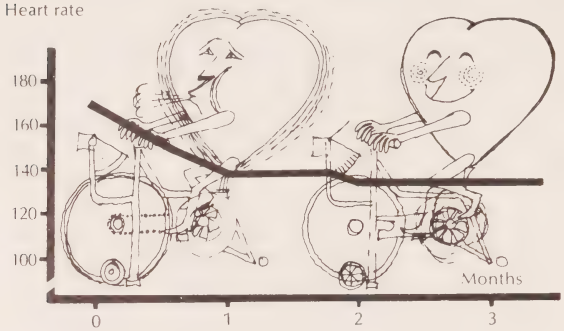


Fig. 2. Heart rate after approximately five minutes work on a bicycle ergometer (load 150 watts) in conjunction with three months of training. Note that heart rate gradually declines thanks to training of the heart.

effect is just the opposite compared to inactivity. Muscular mass, blood volume, the power of heart muscle and even the number of blood vessels all increase. If an untrained person has a heart rate at rest of 70 beats/min training can reduce this rate to 60 or less as proof that exercise has had the desired effect. A job which previously required a 170/min heart rate can be managed with 150, 140 or less, depending on the intensity of the training. (Fig. 2.)

As mentioned, the lower heart rate implies that the work being done by the heart is more efficient and less demanding. Unfortunately, active training is the only realistic "medicine" that can induce this beneficial effect physiologically. It is possible for the heart rate to be recorded continuously over 24 hours. Such recording have shown that even moderate training (as suggested below) can save some 10,000 to 20,000 heart-beats per day! The training itself costs only some 2,000 extra heart-beats per day. (The medical consequences of this are difficult to evaluate but the figures are of great interest as an illustration of how heart work can be modified.)

To summarize, certain tissues such as muscles, bone and blood and also a number of bodily functions can adapt to inactivity — and to stress. Inactivity impairs the capacity for physical work, while a well-adjusted load improves it. (Fig. 3.) The degree of

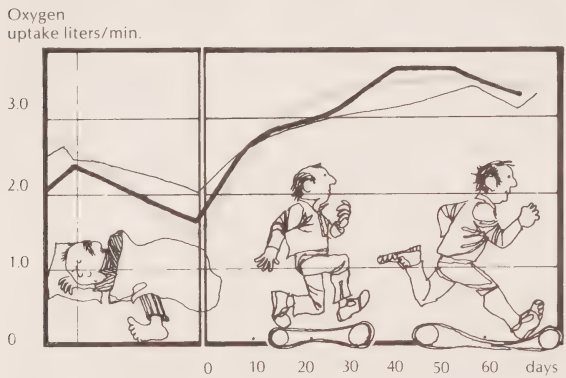


Fig. 3. The effect on maximal oxygen uptake of continuous bed rest for three weeks followed by rather intensive training. The three subjects were habitually inactive before the experiments. Note the 100% difference in the power of the "combustion engine" when comparing the data after training with that after bed rest. These changes reflect the variation in the heart's ability to pump blood.

improvement is not determined by the duration of work or training. The decisive factors are the intensity and tempo of training. This will be discussed further in a later chapter.

Motives for regular physical activity

An athlete needs no reason for his training — this is absolutely necessary for good performance. His problem is **how** to train. Science can help him to some extent in his preparations, even if many questions remain to be answered.

Athletes need to train, but why should the rest of us keep in shape? It has already been pointed out that the human body is built for movement and that movements are a prerequisite for good function. Regular exercise can be compared to lubrication in the care of a car. In certain situations, good physical condition can save lives, for example, in emergency situations in the wilds or at the beach. However, the aim of regular training and exercise is not to produce great maximum motor power but to achieve the essential by-products which training provides.

Cardiovascular diseases

are the cause of more than every second death in most industrialized countries. Naturally enough, intensive research is being conducted into the cause of these disorders and how they can be counteracted. They certainly cause personal suffering and their social and economic consequences are enormous.

Here let it merely be pointed out that several factors such as heredity, diet and way of life seem to be of importance in the development of cardiovascular diseases. Individuals showing high blood presure or

obesity or a high concentration of cholesterol and triglycerides in the blood or a combination of these run a higher risk of death from cardiovascular diseases than the non-obese with normal blood pressure and a low cholesterol and triglyceride level.

In recent years interest has been focused on the possible role of physical inactivity in the genesis of these diseases. In studies published so far it has been shown that inactive individuals run a risk of death from cardiovascular disease which is two to three times greater than that run by the active. The probability of surviving the first heart attack is statistically two to three times greater for those who have previously been physically active than for those who have been inactive. These are statistical correlations and do not prove that the degree of physical activity has actually been the sole and decisive factor. The studies were carried out on selected groups of individuals, and it is possible that certain factors that determined choice of profession or degree of activity during leisure time may also have independently given rise to some sort of prevention against cardiovascular diseases.

However, there are physiological explanations as to how physical activity could be beneficial. Investigations on animals and observations on men have revealed that physical training can open up more blood vessels in the arterial tree in the heart muscle, that is collaterals may develop in the coronary arteries. Similarly collaterals may develop in peripheral arteries. A narrowing or occlusion of a vessel due to arteriosclerosis will not mean the same catastrophe if there are other vessels that can take over the transport of blood with its oxygen and nutrients to the tissue peripheral to the damaged vessel.

Regular physical activity will also favourably influence the level of triglycerides and possibly of cho-

lesterol in the blood, particularly in patients with elevated blood lipid levels.

Research in this area is very complicated and it may take a hundred years or more of intensive studies to demonstrate with certainty that there is or is not a connection between cardiovascular diseases and habitual inactivity. The question is then critical whether we should wait so long for final proof one way or the other. In my opinion there is much indirect evidence that regular physical activity, or training, has a beneficial effect on the functioning of the heart that the opportunity must be seized now actively to affect health in a positive way through a systematic improvement in physical fitness by training.

Once again I repeat the more teleological approach; we are constructed for activity; we once had to run in order to survive and if we are to maintain ourselves in a state of optimum function we must from time to time be physically active; we still have to run for our lives!

Training of the oxygen transport system, including the heart and circulation, is particularly important then both as a prophylactic measure and as treatment.

Weigh what you weighed in your twenties!

People in most European countries and also in North American tend to put on weight after the age of twenty-five, an aesthetic problem which is also a health liability. There are no simple height-weight tables which can indicate with certainty if a person's weight is normal or if he/she is over- or underweight. A person may be heavy without excess fat while a light person may be obese. **A good rule of thumb is that a person's weight should not increase after his/her twenties.** Since muscular tissue declines in most of us, a loss of a few pounds is actually good proof that there is no increase in fatty tissue.

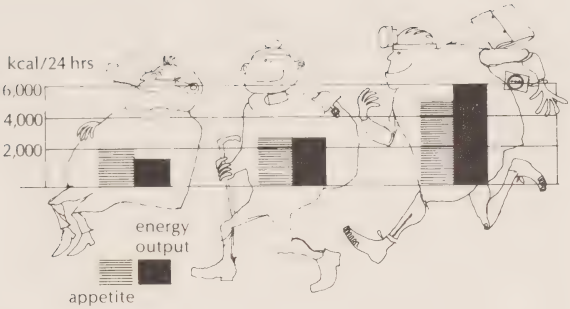


Fig. 4. The diagram shows three persons with different levels of habitual physical activity. The man to the left moves very little and "burns" no more than 1,800 kcal/day but his appetite "demands" some 2,000 kcal. He has to accept being hungry if his weight is not to increase.

The man in the middle is more active and has a balance between his appetite and energy output.

The cross-country runner to the right can symbolize a very active day. He "burns" more calories than he is interested in eating up.

New sensational findings in respect to dieting turn up at regular intervals. Sometimes, fats are to be avoided, sometimes carbohydrates get the blame, etc. The actual truth is rather simple. If the number of calories ingested corresponds to the number consumed in the metabolism, body weight does not change except for small variations of up to a couple of pounds (1 kg) a day which may occur, mainly due to fluctuations in the body's water content. All excess calories are converted into fat. It matters little if the calories are in the form of fat, carbohydrates, protein or alcohol.

Obesity is only occasionally due to pathological or organic disturbances. Both fat children and fat adults are actually less physically active than people with normal body weight. Two pounds (1 kg) of fat correspond to about 6,000 kcal. A person with a sedentary occupation and little body movement during leisure

needs 1,500 - 2,500 kcal a day depending on body size. Athletes in hard training and people engaged in heavy manual labor consume up to 5,000 kcal/day. Thus, energy output/day varies between the amounts of energy represented by 11 oz up to about 2 lbs of fatty tissue. Energy requirements are usually covered rather closely by the corresponding supply of energy in the form of food and beverages. But with habitual inactivity the appetite is often set for an energy supply **greater** than the need. We could put it this way: we can choose between being habitually inactive but often hungry or being fairly active and therefore able to eat what we like!

If a person takes in 50 kcal/day more than he needs, his annual surplus would be 18,000 kcal, corresponding to nearly 7 lbs (3 kg) of fat. This could lead to a 70 lb (30 kg) weight increase in 10 years. If you should one day decide to eliminate your routine mile-walk each day but maintain your eating habits, statistically you will gain 100 pounds in 10 years! It's not surprising that obesity's approach is stealthy as life becomes more sedate, thanks to the auto, more sedentary jobs and less time devoted to exercise. In this context, the period between 25 - 30 years is rather critical.

The caloric contents of some food items are listed below:

This table indicates the average calorie content of:

4 cubes of sugar (12 grams or 0.4 oz)	50 kcal
1 piece of pastry or cake	250 "
1 roll	150 "
6 grams (0.2 oz) of butter or margarine	50 "
1 slice of buttered bread	100 "
65 grams (2¼ oz) of unfilled chocolate	350 "
100 grams (3½ oz) of boiled potato	90 "
1 bottle of beer	135 "
4 cl. (1.4 fl. oz) of brandy	120 "

2 dl. (6.8 fl. oz) of milk	120 "
2 dl. (6.8 fl. oz) of skim milk	75 "

The most gentle way to reduce weight involves allowing plenty of time for measures to take effect. Menus should be critically examined and about 100 kcal be eliminated by, for example, excluding sugar or replacing with an artificial sweetener, and ordinary milk with skim milk. Furthermore an extra 1½ mile walk (2 km) per day would add 100 kcal to the expenditure. The results then correspond to a total of 200 kcal. If everything else remains the same, after a month the body will be holding 6,000 kcal less than before, equivalent to about 2 lbs (1 kg) of fat. Twenty-five lbs (12 kg) should have been eliminated in a year!

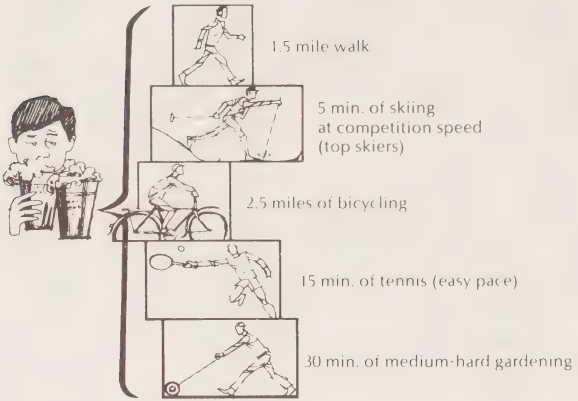
If rapid results are desired, increased exercise can be combined with a strict diet so that only 800 - 1,000 kcal/day are eaten. That would be a tough program for unfortunately there is no diet which is low in calories but which still leaves you satisfied. Weight loss is often striking the first few days, but this is mainly due to loss of body water and not loss of fat. It should also be pointed out that fat cannot be massaged or kneaded away nor can it be "shifted" from one place to another.

In summary, increased physical activity during which neither intensity nor speed need to be high and a change from a diet rich in fat and sugar to one containing relatively more protein is the best regime for maintaining (or reducing down to) normal weight, which for most middle-aged or older people is what they weighed when they were about 20 years of age. It is a mistake to avoid carbohydrates (for instance in potatoes, bread or rice) completely as muscles and nerve cells need carbohydrates in their metabolism. This is particularly important for anyone who is physically active.

Fig. 5. 50 kcal extra/day leads to a nearly 7 lb (3 kg) weight increase in a year. The form in which the extra calories are ingested does not matter.

Fig. 6. A **brisk** walk, jogging or running ¾ mile corresponds to an energy cost of 100 kcal.

Fig. 7. It's easy to feed 100 kcal to the body but difficult to burn them, as the drawings illustrate.



A proper diet is important

Studies have shown that many individuals often live on a diet with fewer than 2,000 kcal/day. The explanation is that they are habitually physically inactive. However, with traditional diet an intake of more than 2,000 kcal/day is necessary to satisfy the body's need for most vitamins, minerals and proteins (Fig. 8). If the diet has a preponderance of foods with low contents of these vital substances, which is the case if it is rich in fats, sugar, sweets, snacks, cookies and cakes, the risk of malnutrition and disease increases.

Some 25% of the women suffer from iron deficiency anemia. In some areas of the U.S.A. it is reported that up to 60% of teen-age girls have an intake of some vitamins below the recommended amount. Some of our "modern" diseases including arteriosclerosis, may at least partly be consequences of a

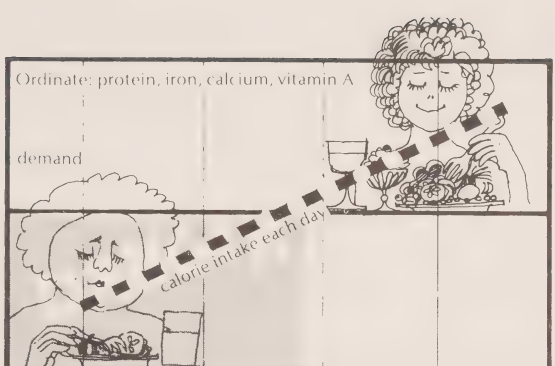


Fig. 8. The supply of most essential nutrients is roughly linearly related to the daily caloric intake, but the **demand** of such nutrients remains constant. The risk for malnutrition is minimal among high caloric consumers, i.e. the physically active person.

chronic malnutrition! The best way for low calorie consumers to guarantee an adequate diet is for them to become high calorie consumers by increasing their degree of physical activity. Thereby they can eat more and automatically get more of essential nutriments. Eating is one of the definite pleasures in life; if you are physically active you may eat more without becoming obese. So in summary, those who are habitually inactive must watch their diet very carefully and select food items rich in essential nutrients. For the physically active individual the choice of food is less important and critical.

Back troubles

Diseases in the spinal column rank very high on the list of common diseases. They are responsible for many days of sick leave and thus give rise to economic problems and cause much suffering. When a

load is lifted or carried, a reflex mechanism calls the trunk muscles into action to fix the rib cage and to compress the abdominal contents. The intracavitary pressures are thereby increased and aid the support of the spine. Such observations emphasize the important role that the trunk muscles have in supporting the spine. While flabby abdominal muscles may leave the spine exposed to injurious stress, well-developed abdominal muscles, on the other hand, are an important protective device which can prevent damage to the spinal column and its resultant backache, etc. To be sure, the trunk muscles probably have no influence on the inevitable changes in the spinal column that come with age, but if they are well developed and trained these muscles can, to a great extent, prevent the symptoms caused by the occurrence of a weak back. Walking or runnings upstairs or uphill will train the leg and trunk muscles. Simple, but if possible daily, exercises will also strengthen these muscles. As back troubles are so common, it is important to encourage workers to keep the trunk muscles fit. It is also important that everyone knows how to lift and carry loads in a way that reduces the load on the spinal column.

A hot environment and water balance

Some people feel they should drink as little as possible when working and when it is very hot because if "you drink just a little, you perspire less." However, studies have shown that sweat production is rather independent of the body's fluid balance. Moreover, sweating is the mechanism which prevents overheating of the body when it is warm or when heavy work is performed. Therefore, under such conditions sweating is very desirable. If fluid is not replaced at the same rate it is lost, performance

capacity and fitness decline and the feeling of exertion increases. Heart rate and body temperature rise abnormally. You should, thus, drink deliberately, possibly even more than thirst "orders" when you sweat. But you should not drink too much at a time nor drink very cold drinks.

Smoking

Within a few minutes of smoking two cigarettes, breathing resistance increases to two or three times the normal value. One may not notice this at rest since relatively little air is required. But breathing may become the limiting factor during exercise with its increased demands on the respiratory system. The smoker is usually short of breath with exertion.

Smoking also affects the heart and blood circulation. Two cigarettes just before muscle work may, thus, raise the heart rate to a level 10 to 20 beats above the normal. Both the carbon monoxide and nicotine in smoke play important roles as triggers of this effect. Carbon monoxide combines with hemoglobin in the red blood cells 250 times more readily than oxygen. A smoker may have about 5% or more of his blood cells blocked by carbon monoxide. Moreover, this gas makes it more difficult for the red blood cells to yield their oxygen to the tissues. Thus, the smoker's heart has to pump more blood per unit of time in order to transport a given volume of oxygen, and the load on the heart increases. Accordingly, smoking causes a decline in physical condition, the extent of which is determined by the number of cigarettes (which have a greater unfavourable effect than cigar or pipe smoking) smoked.

The instinct of self-preservation undoubtedly explains why athletes in endurance events seldom or never smoke!

Some training advice

Caloric consumption

Within wide limits, when walking **fast,** jogging or running, the speed is unimportant as a determinant of the energy cost per mile. The point is then to cover a certain distance. A 150 - 160 lb person consumes about 50 kcal by walking at 3 mph (5 km/hr) and about 80 kcal by walking at 5 mph or running at any speed about half a mile (1 km). Taking walks, preferably a mile or so a day, will provide long-term benefits. You could, for example, get off the bus a few stops earlier and get on a few stops later. If it's not too far, you can walk or cycle to work in good weather.

Getting in physical shape

Walking at an easy pace improves physical condition somewhat. Therefore training should begin at a gentle pace with patients or people completely out of shape. However, conditioning is more efficient if the pace is increased. One effective training method is to have large muscle groups working hard — **but not at maximum** — for a few minutes. One should then rest or "take it easy" for a few minutes, work harder again, etc., three to five times. A quick walk, jogging, running, skiing, cycling, swimming, rowing, skipping-rope and jumping in place are suitable work forms.

The reason why pace should not be at a maximum is as follows: if you run at a certain pace, for example 7 mph, the "combustion engine," with its demand for oxygen, transported by the blood, supplies the energy. When speed is further increased the anaerobic motor has to satisfy the increased energy demands while load on the heart is not further increased. The 7 mph speed provides full exercise for the heart and circulation while a still higher tempo

develops the ability to utilize anaerobic processes and to tolerate lactic acid. Training at maximum speed for a minute or so is very strenuous. It is an inevitable part of the athlete's training program, but it is wise to exclude it from the training of others. The conclusion is, thus, that a distance that can be covered in about 3 minutes can be run in 3½ or even 4 minutes without being less effective in conditioning the cardiovascular function.

As a guide I would say that if the heart rate rises to 200 minus your age in years (i.e. 165 for a 35-year-old), a good training effect is probably achieved. However, the individual variations in maximal heart rate are large, and therefore this rule should not be followed too strictly.

Strength training

A distinction should be made between isometric or static and dynamic work. With static contraction of the muscles there is no movement in the joints in question but movement arises with dynamic work. There are in fact few exercises which are completely dynamic since a great many muscles always have to work statically to provide muscles working dynamically with good support and work conditions.

If you wish to improve your maximum strength, you must work against hard resistance. Endurance training, on the other hand, is best undertaken with lighter resistance and with many repetitions.

For general training of the muscles, work should be chosen against a load big enough to be managed just 5 - 10 times. You can use barbell weights, muscle developers or your own body weight as loads. Strong persons could, for example, do 5 - 10 push-ups at a fast pace. Weaker persons could do the push-ups with their hands on a sofa, table or wall instead of the floor. The position of the hands can be lowered as muscle strength increases.

You can strengthen your abdominal muscles by lying on the floor on your back with knees bent and lifting your trunk (See Fig. 9:7). The movement is easier if the feet are supported. It should be done 5-10 times, possibly repeated after a pause.

The back muscles can be forced to work if you lie on your stomach and try to lift your legs and the upper part of your trunk off the floor. People with stiff backs should lie on a proper cushion placed on a level with the pelvis (See also Fig. 9:8). The exercise is repeated some 5 to 20 times.

Leg muscles are trained by walking up stairs, skipping rope and jumping or running in place. A good way to train is to climb up and down from a steady chair — the classic (but somewhat boring) step test! Running 20 - 25 strides up a steep hill or up as many stairs, walking down and then running up again about 5 times is also effective training in this respect.

Muscular strength is dependent on both muscle mass and the function of the central nervous system. The repetition of a given movement will result in an improvement in that particular activity, but will have much less effect on another movement, even if it happens to be related. The transfer effect, as it is called, is fairly weak. Personally, I believe that dynamic exercises have a more all-round effect than isometric training. Certainly trunk muscles work predominantly isometrically in many daily activities, but they will become trained for these tasks, for in many of the activities that engage the arms and legs they work isometrically to stabilize the pelvis and trunk.

Cardiac patients should avoid isometric exercises and also heavy work involving small muscle groups (like push-ups, chin-ups). Such activities load the heart abnormally since the heart rate and arterial blood

pressure become higher than in dynamic work with large muscles.

Flexibility

Joint movements are necessary to counteract stiffening and impairment of the metabolism of the articular cartilage. Movements are made to their limit, gently and without violent stretching. It should not hurt under any circumstances. The training program in Fig. 9 gives examples of different movements. The exercises should be repeated several times a day with elderly or handicapped persons (unless a doctor or physical therapist has prescribed something else). Some simple, daily movements should be as natural for everyone as brushing teeth!

The Swedish training track

Fig. 10 gives some examples of a simple but excellent form of training.

In Sweden during the last decade simple training tracks have been constructed in most larger communities — they have sprung up like mushrooms! They are located in parks or other suitable areas and consist of a smooth surface, often covered with a mixture of sand and sawdust, about 1½ - 2 miles long and a few feet wide. This winding, cross-country track is frequently illuminated since the Swedish winter is dark and the track provides excellent facilities for cross-country skiing. These tracks are very popular and you will occasionally find them overpopulated by individuals of all ages who walk, jog or run their one or two laps. During the summer of 1971 a competition was held between Finland and Sweden: 1½ miles gave ½ point and a maximum of 1 point per day could be scored per capita. Sweden won!

Fig. 9. An exercise program for home use, by Kim Myrenberg. Always warm up slowly; gradually increase repetitions of each exercise according to your fitness level.

1 Stretching

- Stretch arms up and out slowly in various directions.
- Use the legs and trunk as well, to make it a total-body stretch (like a cat!).

2 Back exercise

- Clasp hands behind back.
- Drop upper body forward over bent knees (count 1-2).
- Slowly uncurl up to standing position (count 3-4) and pull shoulders back.

3 Body Twist

- A total-body movement using all joints.
- Swing both arms sideward and upward, bouncing back gently for 3 counts (1-2-3).
- Swing arms over to other side in relaxed (knees-bent) fashion on the count of 4.

4 Leg Exercise

- Start with feet well apart
- Bend knees and touch palms to floor between legs (count 1)
- Slap hands on knees (count 2)
- Straighten up and clap hands together overhead (3)
- Slap hands on bent knees again (4)

5 Lunges

(for toning calf and thigh muscles).

- Lunge forward with left leg, knee bent, and right leg held straight behind (count 1-2-3).
- Jump up brightly on count of 4, to bring feet together.
- Repeat, alternating legs.

6 Swedish Hambo

(to improve circulation).

- Alternating feet, roll up onto toes in pedalling motion for 6 counts.
- Jog on the spot lifting knees high (6 counts).
- Pedalling again for 6 counts.
- Then hop forward feet together to crouch position (count 1-2).
- Hop back feet together to standing (count of 3).
- Repeat forward hop to crouch (1-2) and hop back to standing (count of 3).
- Repeat entire sequence.

7 Sit-ups
(for abdominal muscles).
- Lie on back, knees bent and feet flat on the floor.
- Lift head, shoulders, and upper trunk, and stretch hands to knees (count 1-2).
- Slowly uncurl (keeping head forward) back to starting position, arms on the floor (count 3-4).
- Squeeze abdominal muscles through counts 1-2-3 and relax on 4.

8 Knee-scale
(for back muscles and buttocks).
- Start in hands-knees position on the floor.
- Rock back to sit on heels, touching chin to knees and keeping arms outstretched on the floor (count 1-2).
- Rise to original position (3-4).
- Arch back and lift head while stretching one leg out and up high backward (count 1-2).
- Return to original position (3-4).

Grand Finale (9, 10, 11) A rythmical, fun workout to improve cardiorespiratory fitness.*

9 Twist-Hop
- Hop twice on right foot, while pulling left knee up high and across front of body to touch right elbow (count 1-2).
- Repeat: 2 hops on left foot etc. (count 3-4). Continue

*Try to find some stimulating, lively music to do these exercises to. If you are out of shape or overweight, do the exercises without jumping—just walk through them.

10 Leg Kick

- Hop on right foot, swinging left leg up in front.
- Hop on both feet
- Hop on the left foot, swing right leg up
- Hop on both feet.
  (To increase difficulty, lift leg higher and clap hands under knee on each kick)

11 Ski Exercice

- Hop on the spot with feet together, twisting hips so that knees are turned to right on count 1, to left on count 2, to right on count 3, and etc.
- Relax and bend knees with each hop. Arms are held out as if skiing.

*Try to find some stimulating, lively music to do these exercises to. If you are out of shape or overweight, do the exercises without jumping—just walk through them.

This program takes a total of 30 to 40 min. This or similar training should be undertaken one or more times a week and helps to build fine physical condition. Training may be concluded with a sauna, shower or the like.

Program for untrained or elderly persons

The basic pace is ordinary walking speed. Begin leisurely and gradually increase the pace but not so fast so that you become out of breath.

FIVE MINUTES WARM-UP
1. Walking

FIVE MINUTES OF SPURT TRAINING
2. Take 20 - 30 strides at a rapid pace, preferably uphill.

3. Recovery between spurts.

15 - 20 MINUTES OF INTERVAL TRAINING
4. Brisk walk for 2 - 4 minute periods.

5. Rest or slow walking between periods.

When you improve your physical condition, you can introduce intervals with jogging for 50 yards and walking for 50 yards.

Program for people in good physical condition

FIVE MINUTES WARM-UP
1. Alternate jogging and walking

FIVE MINUTES SPURT TRAINING
2. Running 20 - 30 strides at top speed about five times, preferably uphill.

3. Recovery between spurts

15 - 20 MINUTES OF INTERVAL TRAINING
4. Run at about 80% of top speed for 2 - 4 minute periods

5. Rest or jog between periods

It is convenient to arrange dressing rooms, simple playgrounds (for children's games, volleyball, table tennis, basketball, etc.) adjacent to the training tracks.

Personally, I like to change to suitable clothing at home and drive out to the track. As a warm-up: walking alternating with jogging for about five minutes. That takes me to a steep hill, climbed with 20 - 25 steps at top speed, thereby loading the legs and buttocks musculature. Walk down, brief pause and a new rush up again, repeated about five times.

Fig. 10

This phase takes about five minutes and is not as exhausting as it sounds since each work period is brief. Training of the cardiovascular function then follows with repeated 3 - 4 minute periods of running with a 2 - 3 minute rest or easy walk in between. As already mentioned, maximum speed is **not** used: about 80% is the level. My training round comprises four "conditions sections." Some 30 - 35 minutes later I'm back at the car and drive home to enjoy a shower.

One suggestion: Don't run downhill! The risk of injury is very great and the conditioning effect is rather modest.

The goal is to devote two or three half-hours a week to training: The reason for this form of training is that walking and running are natural activities. With large muscle groups at work, exertion is moderate and the training effect still good. You are not dependent on others as in team sports and you can always find some place to train, even while travelling in your own country or abroad. It does not matter if you train in the morning, afternoon or evening.

Practical circumstances have to decide this. Tempo should be adapted to the degree of fitness, health and age. It should not be extended beyond a certain level and checking speed against a stopwatch is therefore not very interesting.

When a certain level of fitness has been achieved you should try and retain it. Training then feels gradually easier. Less training is required to retain good physical condition than to acquire it. That's why regularity is so important. If you begin your "shake-up" by training every day or every other day for a few weeks, you can achieve good results which can be preserved without much effort. Therefore, use your vacation to improve your physical fitness!

Then you have time for rational training and also for rest!

Untrained and elderly persons should choose walking as their work pace when out on the track but should walk faster where Fig. 10 calls for running.

The course illustrates a basic principle in all training: large muscle groups work at varying speeds. Other sports can be designed according to the same principle. Joint and muscle exercises can be done most simply at home. There are training bicycles which you could have at home and use for conditioning, especially when the weather is poor.

At present, covering as long a distance as possible within 12 minutes is a popular training method. In my opinion, this is overdoing things, from a physiological point of view. As was pointed out earlier, it is not necessary to aim at maximal performance if the goal is to improve the function of the cardiovascular system and to burn extra calories. Personally, I heartily dislike being a slave to a stopwatch. I want to pause in the midst of a sprint if I catch sight of a beautiful flower or hear a bird singing (but such stops would sabotage a good time record!). In addition, the principle of struggling to score some 20 - 30 points based on actual performance in a week is also very unsound from a physiological-medical viewpoint. A glance at Fig. 1 shows that some individuals can easily score many points merely because they are fortunate in natural endowment while others who have a low maximum oxygen uptake must work hard to obtain the same number of points. As fas as health is concerned, it is not the absolute amount and volume of training that is important but **the work in relation to the individual's capacity.** The severe, prolonged training of the top athlete adds no health benefits to those of a submaximal training program twice a week! It would be

a pity if point systems and stopwatches should become the be-all and end-all of regular physical activity!

Equipment

For running you need a sweat suit and light cross-country running shoes with good soles, higher under the heels to spare the Achilles tendons. Use thin rubbers over your shoes in wet weather. This equipment, which is lightweight and hardly bulky, should be taken along on trips. For ski training you should give yourself the benefit of a pair of light cross-country skis and ski boots suited to the bindings. Knee-length socks and competition pants as well. Cross-country skiing with down hill skis is not a good idea. There are no all-round skis for all kinds of skiing. Therefore, it's best to get two pairs of skis!

Physical fitness for everyday life

People who perform heavy manual labor usually are in better shape than white-collar workers. Their jobs provide them with a certain amount of physical training. Physically heavy work is absolutely no liability for healthy people. For many reasons, however, it is desirable to have machines take over the heavy steps and to design the job of work to be as comfortable as possible.

One important aim of regular physical training is to achieve a physical condition and fitness that is well above that required for the routine job. If daily work forces the heart to pump ten liters of blood/min with a 120 beat/min heart rate, it is obviously advantageous for a person to be trained for 15 litres/min and a 150 beat/min heart rate or more. In view of this, a

quick walk now and again may be sufficient for a teacher or office worker, but a person who does heavy work should exercise harder a few sessions a week.

In their spare time, people should give their bodies the stimulation in the form of exercise they need to function at their best and for health.

Active recreation

By **active** recreation we mean here a kind of hobby in which some form of muscular work is a part. Examples of **passive** recreation are watching TV, attending concerts or the opera, playing cards or chess and collecting stamps. Both active and passive recreation should be something to look forward to with joy and expectation.

Passive recreation should always be supplemented by active. An active form of recreation is ornithology, that is to say, the study of birds. You go out into the country with binoculars and a field guide to birds. The bird moves and you have to follow it to identify the species and to study details. Other examples of active recreation are gardening, hunting, fishing, botany and swimming. Unfortunately, these activities may be very much dependent upon the season. Therefore, purposeful training in some form should be undertaken, preferably in a way that is really enjoyable. You shouldn't for example, rush through the woods on your training round, trying so hard to beat your record that you are blind to all surprises Nature has to offer.

"Ergometry"

The term "ergometry" stems from the Greek **ergon** (work) and **metron** (measure), and may be translated rather literally as "work measurement." The instruments of work measurement are ergometers, and they vary in their construction according to the form of analysis. Bicycling has proved to be a very suitable work-form, since, among other things, at a given (submaximal) load, it demands about the same energy output whether the subject is young or old, trained or out of condition, elite cyclist or unfamiliar with the sport.

The bicycle ergometer was invented several decades ago and has been widely used in physiological laboratories ever since. This instrument provides an exact measurement of the performed external work, and thus a graded and measurable load can be applied to the subject. The load is adjusted quite simply by varying the tension of a belt running around the rim of the one wheel of the machine, acting as a mechanical brake, while the subject pedals at a constant speed in time with a metronome.

On a stationary bicycle ergometer a standard, submaximal work load is applied for 6 minutes, the heart rate being counted during the last minutes of exercise and noted. In principle the lower the heart rate, the better is the pumping power of the heart. The heart rate of an untrained subject may reach 170 beats per minute during the test. If he then starts to train a couple of times a week, and after a month is again tested on the bicycle ergometer, his heart rate may be found to have fallen to 140 beats per minute, showing that the training has been effective (see Fig. 2).

This test has proved to be a valuable educational and psychological tool for stimulating people to start and

to continue training. In Sweden there are now about 6,000 bicycle ergometers in use. They are available in every school and also in sports clubs, factories and offices; anyone who is interested can take the submaximal test and follow his physical condition over the years.

Society has a big responsibility

As pointed out in the introduction, it costs a lot of money for society to care for the sick. If sick days and poor health could be partly prevented, great savings would be achieved. The money a community invests in active recreation and training may provide tenfold dividends in money saved on medical service costs. The problem that must be faced is that the individual from puberty onward is lazy and the exercise table has to serve "goodies" which tempt people's appetite for training and active recreation. Laying out the Swedish training track, preferably with changing rooms and steam baths (saunas), costs relatively little compared to medical service costs.

It is important to get young people interested in regular training at an early stage. Unfortunately, school curricula tend to reduce the time available for physical training and recreation rather than increase it. This is regrettable since it is during their school years that young people must acquire understanding and motivation and learn the program that is so important for good habits including continued regular exercise. Anything neglected during adolescence can in many cases not be made up for later on.

Swedish schools, like those in most countries, have in the past placed too much emphasis on advanced teaching of zoology, biochemistry and the description of isolated organs when dealing with human biology. This has been at the expense of discussion

of the function of the **intact** human body, at rest and during activity. The deeper the knowledge of these functions, the better are the chances to "service" the body properly and to manage the environment.

However, the Swedish schools and universities have one advantage with regard to physical education. The teaching and curriculum are almost exclusively aimed at general training and recreation. The time and resources spent on competitive sports and the coaching of athletes are very limited. Efforts are made to provide service and education for everyone, from the handicapped to the physically fit person. Pupils and students who are endowed for and interested in competitive sports are stimulated to join any of the many sport clubs, normally independent of the schools. After finishing school it is then natural for the former student to continue his sport activities under the auspices of the sport club.

It should also be mentioned that most trade unions organize major sports programs and various outdoor activities (games, skating, bicycling, etc., often as family activities). Such activities are subsidized by the company, and the managers also participate! This sector sponsors soccer, ice hockey, handball, basketball leagues, etc., and the motivation to participate seems to follow the motto of the founder of the modern Olympic Games, Baron Pierre de Coubertin: "The important thing is to participate, not to win!" These sport associations helped to organize the previously mentioned competition between Finland and Sweden.

In Swedish cities and communities, sidewalks are not only provided in the central areas, but in outlying suburbs as well. In my opinion, there has been too much emphasis on the auto while the need for safe walking space has been neglected. There should also be a strenuous program to build safe bicycling lanes and trails to supplement the main roads.

Concluding remarks

I have heard that medical cases have been brought into the law courts with the following background: A man was advised by his physician to start an exercise program. However, he suffered a heart attack. He maintained that the exercise and, indirectly, the doctor were to blame, and therefore the doctor should bear the financial burden. Such a trial has never been and, I hope, never will be brought up in Sweden.

(It would be more logical for the habitually **inactive** person who had a heart attack to "accuse" his physician for not warning him that inactivity was a risk factor for the development of cardiovascular disease.)

Prescription for exercise

Daily — at least 60 minutes of physical activity, not necessarily vigorous, nor all at the same time. During your daily routine, moving, walking, climbing stairs, etc., whether for one minute 60 times per day, 12 minutes 5 times a day, or any combination totalling 60 minutes, will burn up approximately 300 kilocalories.

Weekly — at least two or three periods of 30 minutes of sustained activity (brisk walking, jogging, cycling, swimming, cross-country skiing, etc.) are necessary for maintaining good cardiovascular fitness, and will consume an additional 750 kilocalories per week.

Some physical activity for minimum one hour daily . . . and

some organized training 3 times weekly for some 30 min. give an optimal effect!

Remember!

Exercise regularly, preferably two to three times a week.

Exercise at a modest tempo the first few times, increase the pace slowly and don't "push too hard"; speed should not be maximal!

Never take part in a competition involving physical exertion when you are out of shape, no matter what kind of competition.

Don't exercise hard and don't compete when you have any infection.

Forget now and then that there are things like elevators, buses and cars. Remember from time to time that you have legs and that there are forests and grounds for sports and open air activities.

References

Astrand, P.-O. and K. Rodahl: Textbook of Work Physiology. McGraw-Hill, New York, 1970.

Naughton, J. P., H. K. Hellerstein and I. C. Mohler (eds): Exercise Testing and Exercise Training in Coronary Heart Disease. Academic Press, New York, 1973.

Zohman, L. R. and R. E. Phillips: Medical Aspects of Exercise Testing and Training. Intercontinental Medical Book Corporation, New York, 1973.

Astrand, P.-O. and K. Rodahl: Manuel de Physiologie de l'Exercice Musculaire. Masson et Cie, Paris, 1972.

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